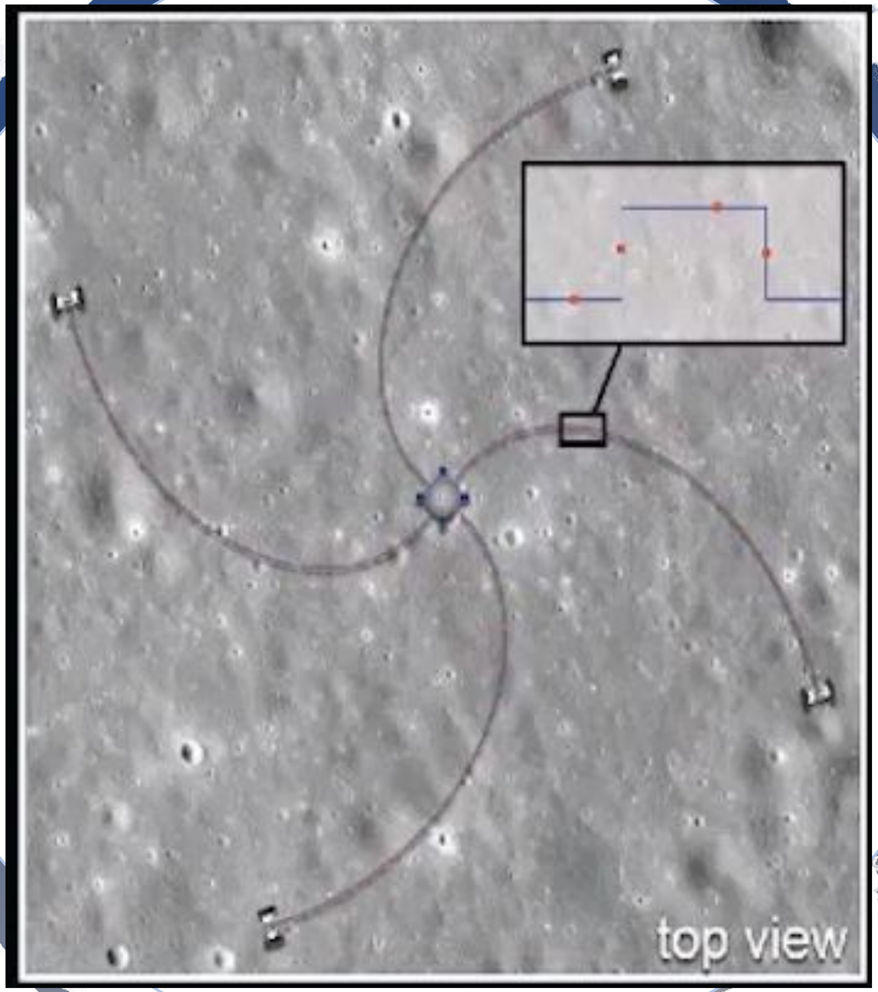

FARSIDE
Polarization configuration

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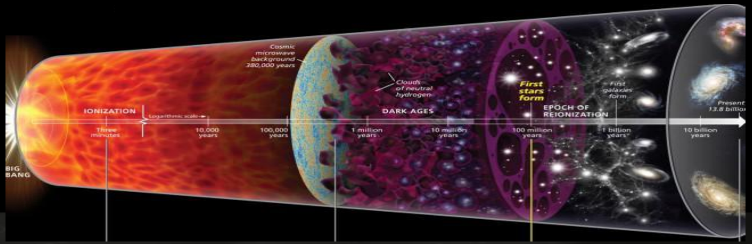
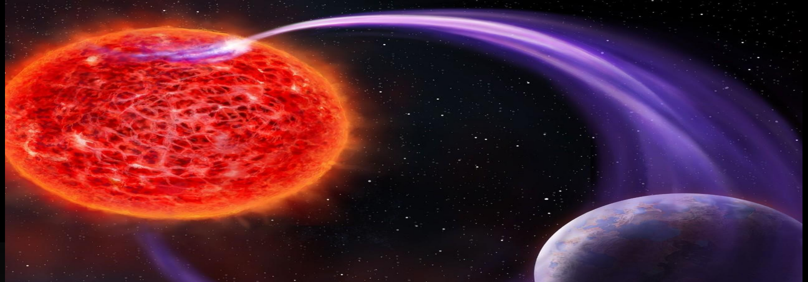


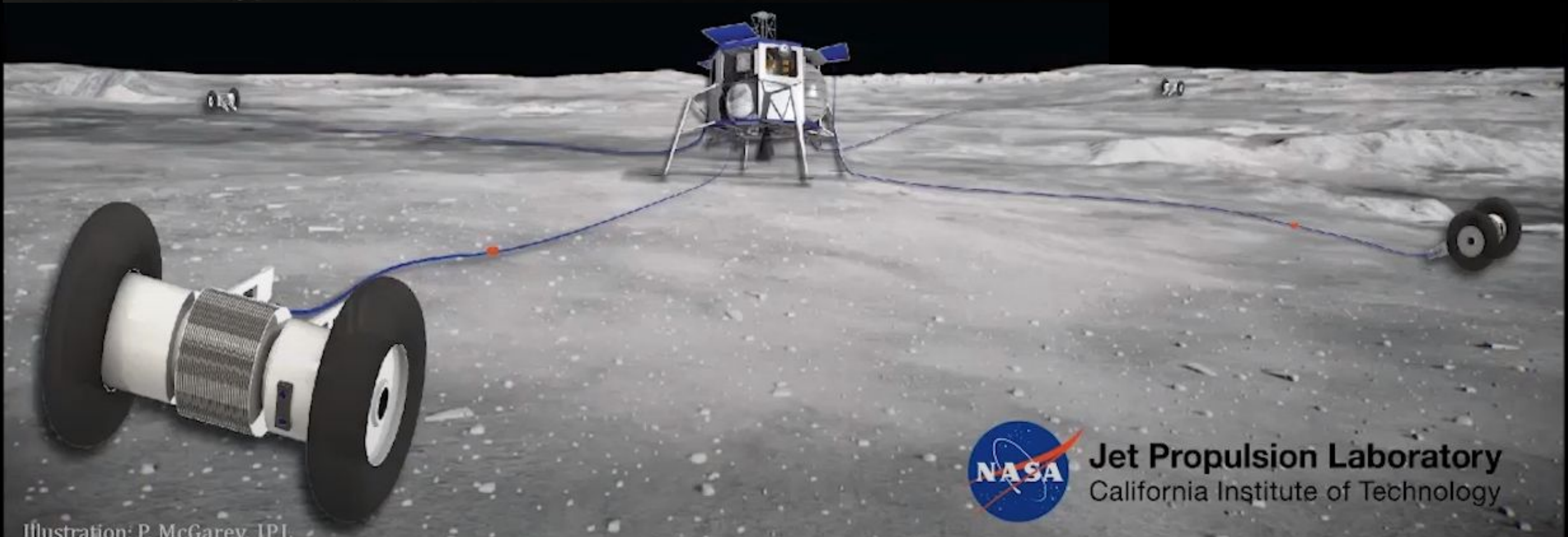
21 cm fluctuations of Dark Ages



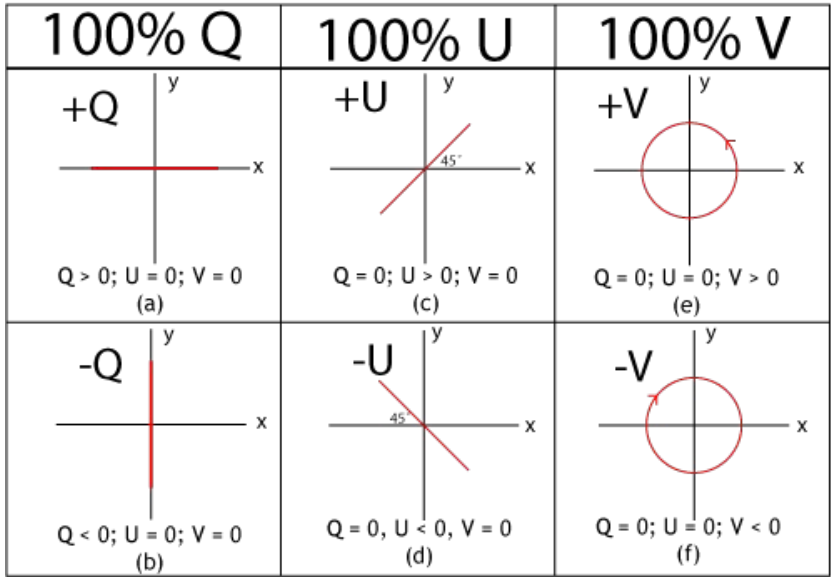
Radio auroral emission from exoplanets

FARSIDE

Farside Array for Radio Science Investigations of the Dark ages and Exoplanets



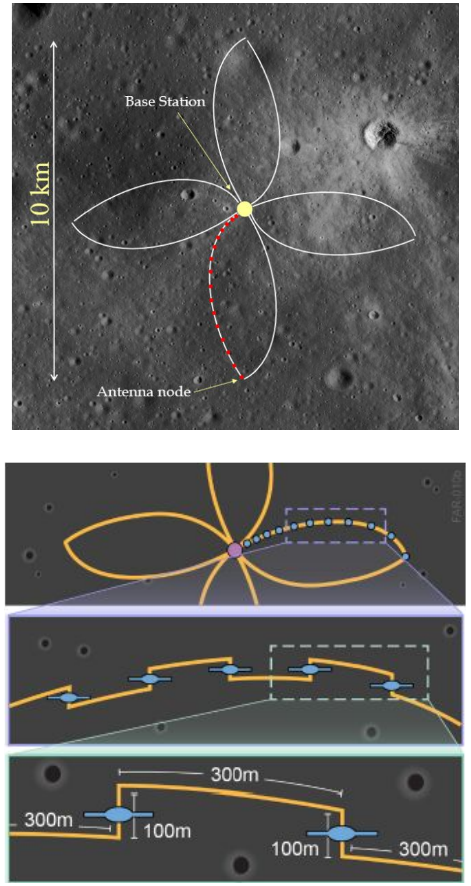
Significance & Need



- Polarization:
  - Any EM wave is associated with a polarization information.
  - How the Electric field is orientated.
- Stokes parameters:
  - Quantifies polarization of a signal
  - I - Unpolarized, Q & U- Linear, V - Circular
- Why does FARSIDE care?
  - Exoplanets → Circular polarization - to separate the host and planet signal
- Importance of this study
  - Instrument effects can cause intermixing of intrinsic source polarization.
  - Antenna offset adds more mixing (compared to co-located arrays)

We must model and understand these effects to maximize the performance of FARSIDE

FARSIDE Notional Layout

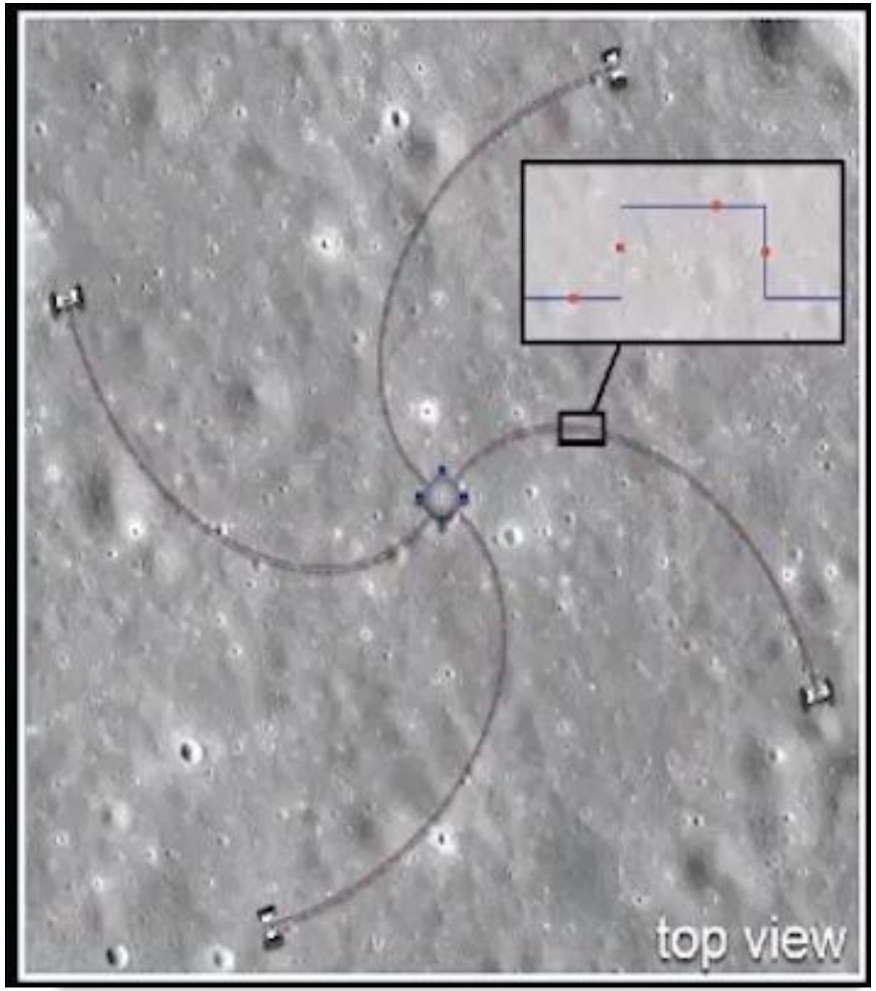


Parameter	Value
No. of Antennas	128
HB – Range	1 – 40 MHz
HB – Deployment	Stacers
LB – Range	100 kHz – 2 MHz
LB – Deployment	Embedded in tether

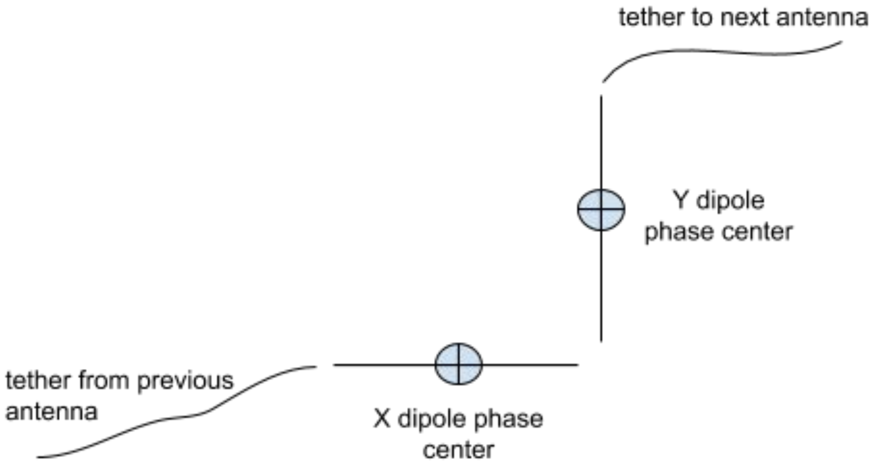
Disadvantages:

- *Limited dual polarization measurements.*
- *Limited Circular polarization data.*
- *Longer integration time (2x).*

FARSIDE Improved Layout

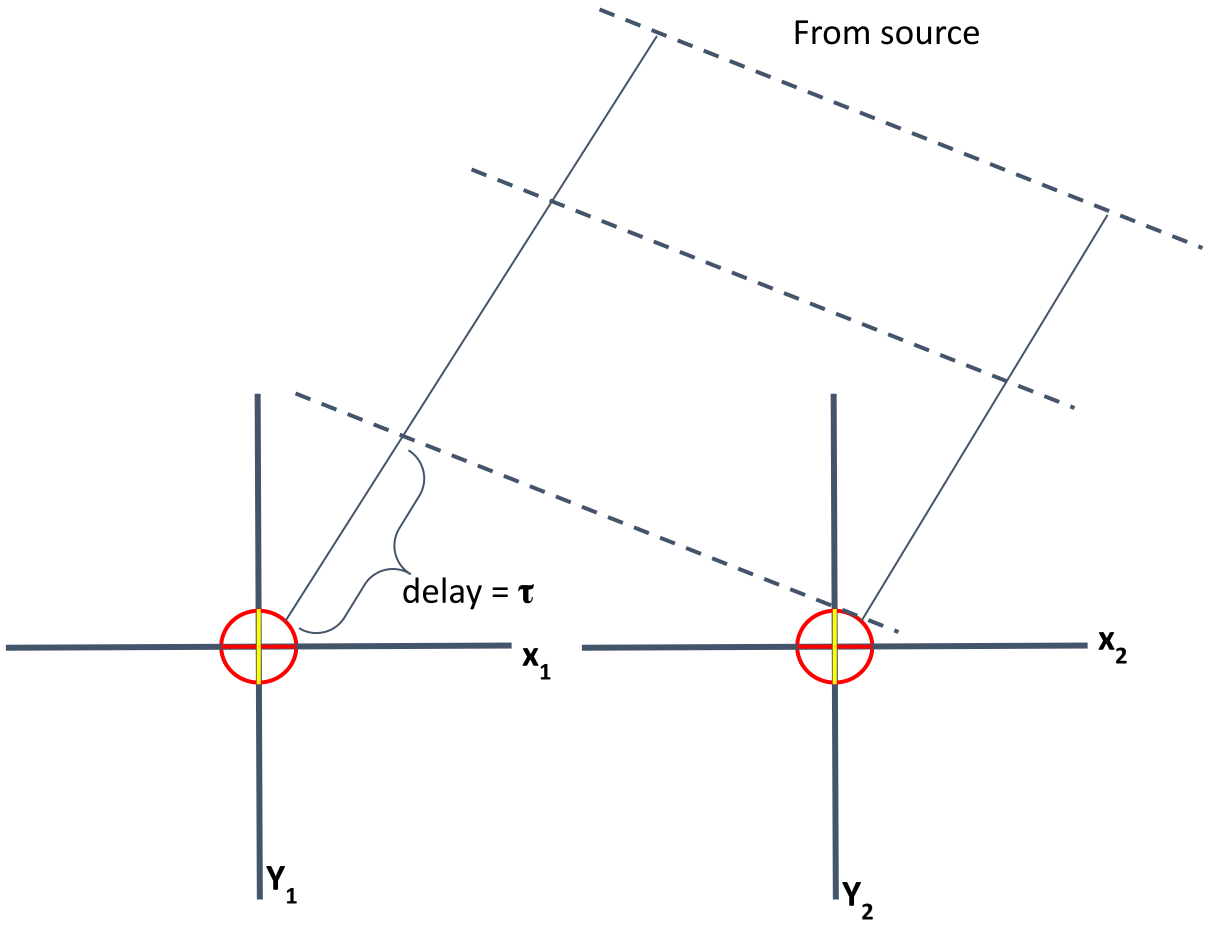


- Advantages:
  - For Deployment
    - Ease of deployment
    - Robust (fail safe)
    - Less load mass on each rover
    - No stacers required
  - For science
    - Better calibration of antennas with dual polarization
    - Circular polarization for exoplanet science
    - Less integration time



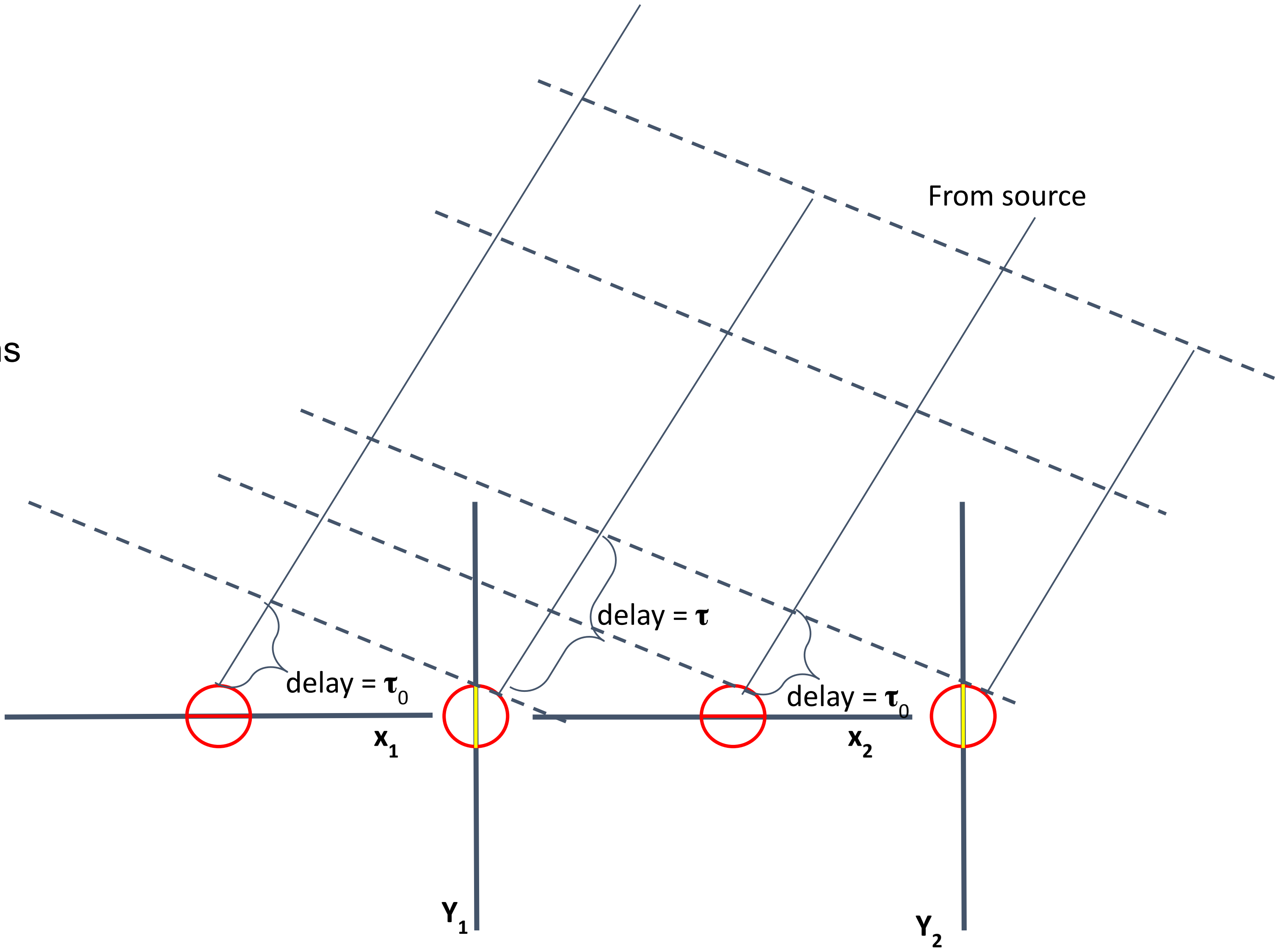
Response of a co-located array - Normal case

- Both polarizations have the same phase center, i.e,
    - The feed is at the same position in space
    - Examples: OVRO-LWA, MWA, HERA
- To create images of the sky signals from all the antenna pairs are combined
- Only one delay to combine them appropriately.



Response of a Non co-located array - FARSIDE case

- In a non co-located array: X and Y antennas are offset
  - Do not have the same phase center
  - Examples: 21CMA
- Extra delay (τ_0) between the X and Y combinations from each antenna pair.
- Additional corrections when combining data from different antennas



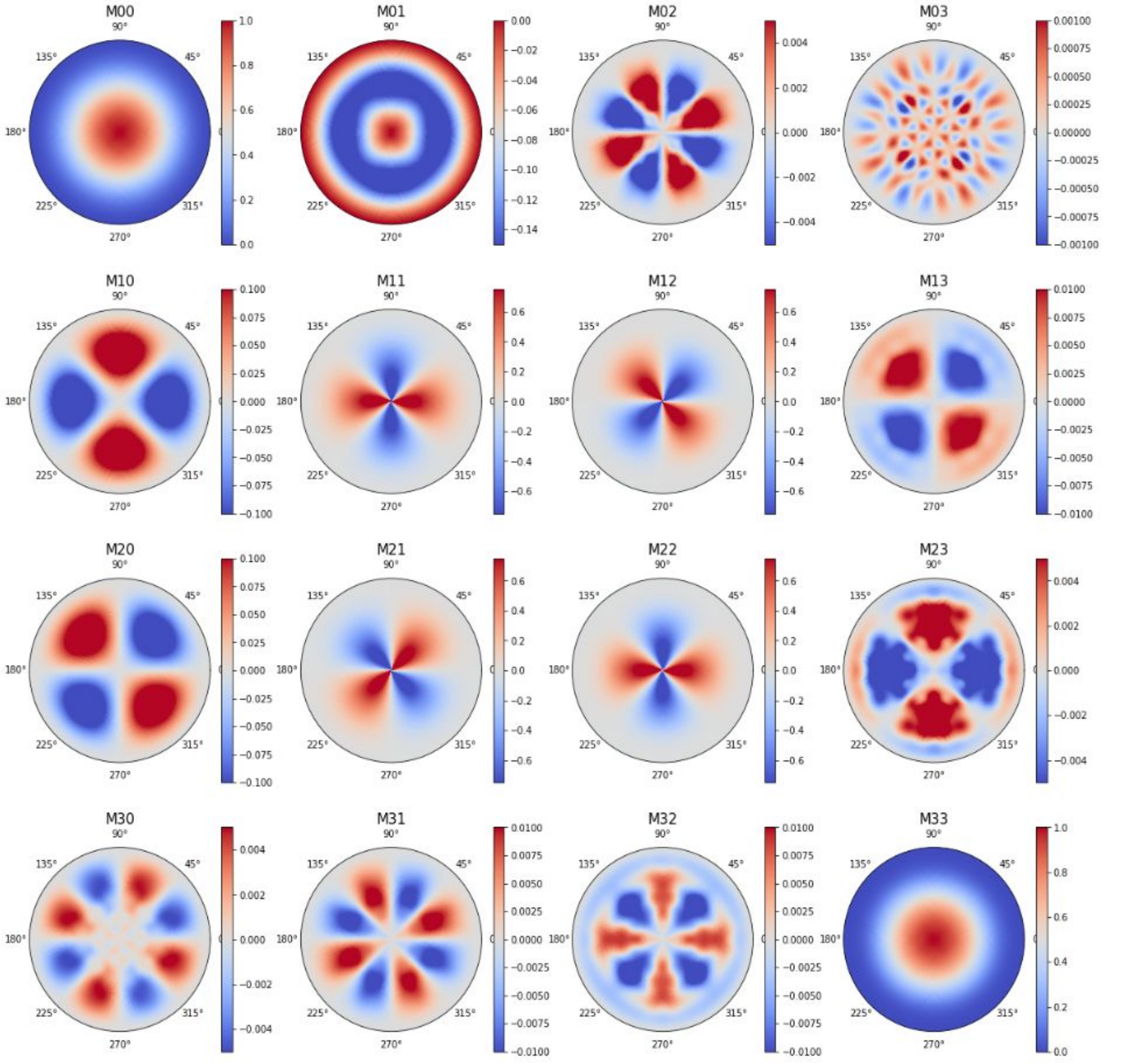
Stokes Leakage: Normal case

- ***Input*: EDGES beam placed orthogonally**

$$J_{beam} = \begin{bmatrix} E_\theta^x & E_\phi^x \\ E_\theta^y & E_\phi^y \end{bmatrix}$$

$$J_{beam} * Sky * J_{beam}{}^{H}$$

- Polarization components:
  - I, Q, U, V
- Plot info:
  - Diagonal terms - Ideal capture
    - I -> A^I, Q -> A^Q, U -> A^U, V -> A^V
  - Off diagonals - Leakage
    - I -> $A^{Q, U, V}$
    - Q -> $A^{I, U, V}$
    - U -> $A^{I, Q, V}$
    - V -> $A^{I, Q, U}$



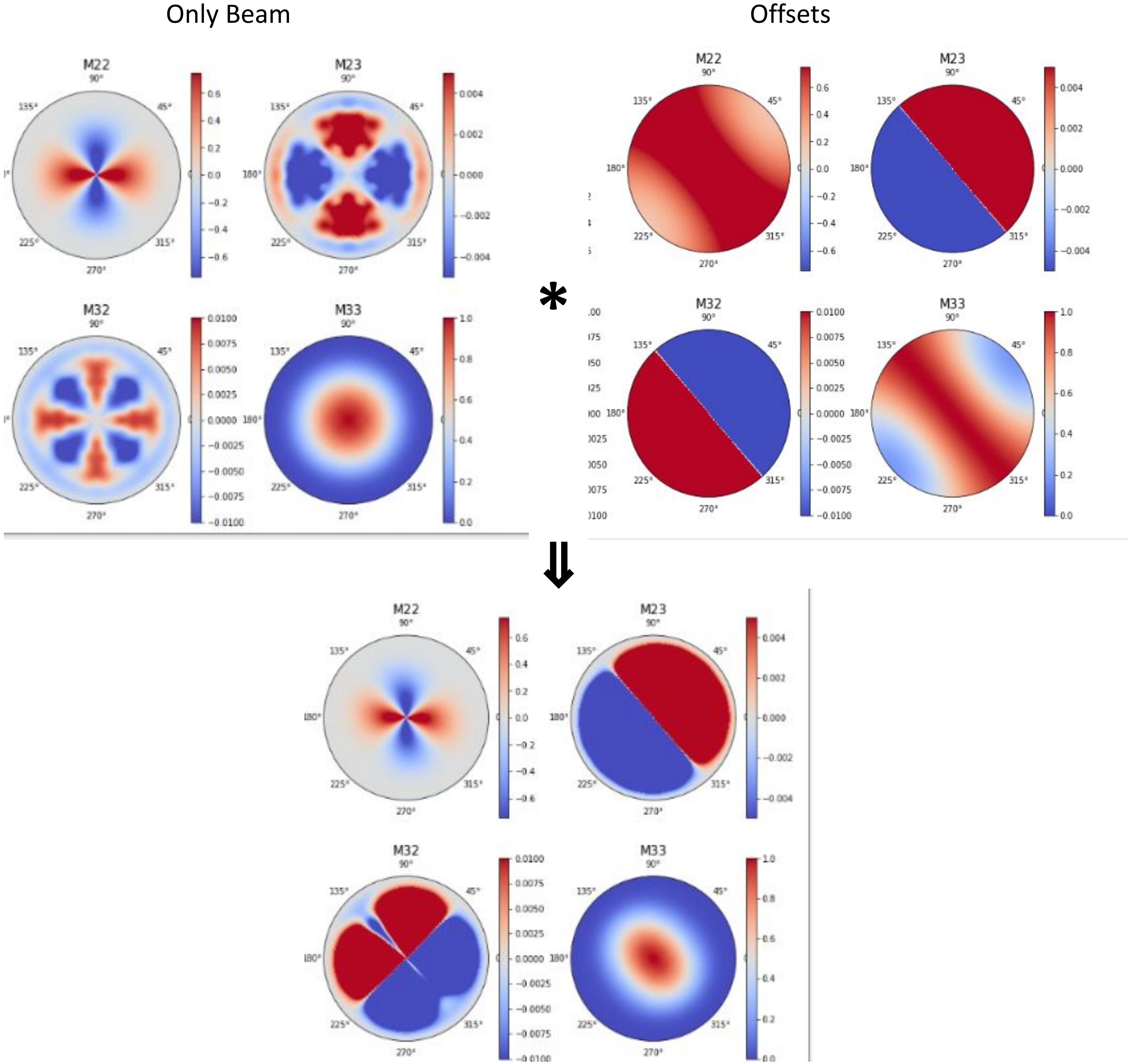
Stokes Leakage: FARSIDE Case

- ***Input:*** **EDGES beam placed orthogonally + Offset the antennas**

$$J_{beam} = \begin{bmatrix} E_\theta^x & E_\phi^x \\ E_\theta^y & E_\phi^y \end{bmatrix} \quad J_{offset} = \begin{bmatrix} 1 & 0 \\ 0 & e^{i\Delta\phi} \end{bmatrix}$$

$$(J_{beam} * J_{offset}) * Sky * (J_{beam} * J_{offset})^H$$

- Adding the offset has a significant impact, especially on the circular polarization signal.
- This impact is shown only for one 1MHz
  - It varies with frequency
  - Errors in the offset



Discussion

- We have developed a formulation to study the antenna and array effects on the polarized signal.
- Using the stokes formulation we will estimate the tolerance level in:
  - Error on the dipole placements and orientation
- We will test the pipeline on real sky models

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Thank you!